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Lichens newly recorded from the South Korean coast

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Abstract — Twelve new records of lichen species are reported from the southwestern coast of South Korea. Among them, ten are crustose lichens and two are macrolichens. *Caloplaca yuchiorum* and *Lecidea varians* are reported for the first time from Asia. The coastal rocky area offers great potential for the discovery of new or previously unrecorded crustose lichens in the country.

Key words — biodiversity, taxonomy, maritime, saxicolous, lichenized fungi

Introduction

The southwestern coast of South Korea where we conducted most of our research is mainly composed of rocks surrounded by thousands of small rocky islands (Pl. 1). In contrast to macrolichens, which have been studied thoroughly (Park 1990), crustose lichens are poorly studied in South Korea. Because the rocky coast area harbors a rich diversity of crustose lichens (Joshi et al. 2009, 2011), we focused the study in this area and found many species that have not been reported previously for the country.

Most of the new records reported in this study were growing on coastal rocks, while only a few of them were on bark. Due to the difficulty of collecting lichens on rock, saxicolous lichens are still poorly studied, compared with the terricolous or corticolous ones. In addition, no expert has studied such crustose genera as *Acarospora* A. Massal., *Ochrolechia* A. Massal., or *Pertusaria* DC. in the region, so that future new discoveries might be found within the crustose lichen groups, especially those occurring in the coastal rocky region.

Materials & methods

Specimens were collected from the western and southwestern coast of South Korea in 2011. Samples were hand-sectioned under Nikon SMZ645 dissecting microscope

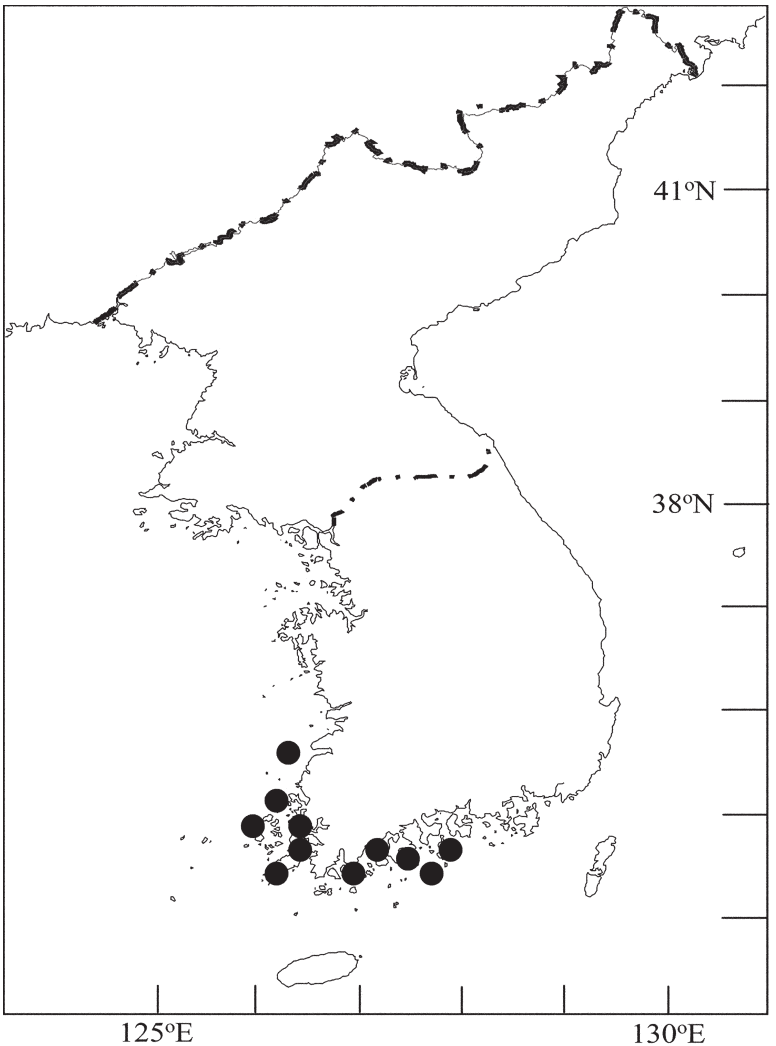

Plate 1. Collection sites for lichens newly recorded from South Korea.

and observed under Nikon E200 microscope using standard microscopical techniques. Lichen substances were identified using standardized thin layer chromatography techniques (TLC) with C system (Orange et al. 2010). The specimens are lodged at herbarium of Lichen & Allied Bioresource Center, Korean Lichen Research Institute (KoLRI), Sunchon National University, Korea.

The new records

Acarospora veronensis A. Massal., Ric. auton. lich. crost.: 29 (1852). Pl. 2A

Thallus medium brown to dark brown, of dispersed areoles, thinly scattered in lines following cracks, or in places as contiguous groups; areoles 0.2–1.0 mm wide, rounded or angular by compression, occasionally slightly lobulate, flat or slightly convex, matt or shiny. Medulla white; lower surface corticated, white to light brown. Apothecia numerous, deeply immersed, round to angular, 0.2–0.4 mm in diam., 1–3 per areole, sometimes confluent, sessile, concave, crater-like, of same color as thallus or reddish brown; epihymenium yellowish brown; hymenium hyaline 60–100 µm high; subhymenium and hypothecium hyaline; Asci cylindrical, more than 100 spores per ascus; Ascospores hyaline, simple, narrowly to broadly ellipsoid, 3–6 × 1.5–2 µm.

Spot tests — thallus: K–, C–, KC–, P–.

Secondary metabolites — none detected.

Specimen examined — **SOUTH KOREA. Gyeongnam:** Namhae county, seaside, 34°43.515′N 127°53.678′E, alt. 16 m, on rock, 28 Apr. 2011, Hur 110244 (KoLRI).

Comments — *Acarospora veronensis* is similar to *A. impressula*, which has more punctiform, less concave apothecia.

Reported from Europe, North & Central America, and Asia (Smith et al. 2009), *A. veronensis* is new to South Korea.

Bacidia egenula (Nyl.) Arnold, Flora 53: 472 (1870). Pl. 2B

Thallus gray-green to yellowish green, crustose, thin to thick. Apothecia flat or slightly convex, 0.2–0.6(–0.8) mm in diam.; disc bluish gray to dull black, epruinose; exciple olive-green at the outer edge, hyaline interior; epihymenium olive-green to blue-green, K–, N+ reddish; hymenium hyaline, colorless, 35–50 µm tall; hypothecium brown to reddish brown in upper part, colorless below. Ascospores hyaline, 3- to 7-septate or indistinctly septate acicular, clavate or long-bacilliform, straight or slightly curved, 25–40 × 1.5–2.5 µm.

Spot tests — thallus: K–, C–, KC–, P–.

Secondary metabolites — none detected.

Specimen examined — **SOUTH KOREA. Gyeongnam:** Namhae county, Changseun Island, 34°51.856′N 127°57.715′E, alt. 4 m, on rock, 29 Apr. 2011, Hur 110289 (KoLRI).

Comments — *Bacidia egenula* is similar to *B. arnoldiana* and *B. viridescens* but *B. arnoldiana* can be distinguished by 1–3-septate spores and a colourless epihymenium and *B. viridescens* differs by its colourless hypothecium and larger thallus granules (80–120 µm diam).

Reported from Europe, North America, and Asia (Smith et al. 2009), *B. egenula* is new to South Korea.

Buellia prospersa (Nyl.) Riddle, Brooklyn Bot. Gard. Mem. 1: 114 (1918). Pl. 2c

Thallus crustose, epilithic, thin to moderately thin, continuous, surface smooth and rimose, slightly roughened, yellowish gray to light gray, epruinose, without soredia or isidia, prothallus absent; medulla white. Apothecia lecideine, 0.5–1.0 mm in diameter, sessile, disc black and plane, epruinose, with black and smooth margin; exciple narrow, inner hyphae hyaline, with darkened outer part; epihymenium brown, hymenium hyaline, paraphyses simple or branched. Asci clavate, *Bacidia*-type, 8-spored, ascospores brown, ellipsoid with obtuse ends, 1-septate, 10–15 × 6–8 μm. Pycnidia not seen.

Spot tests — thallus: K–, C–, KC–, P–.

Secondary metabolites — no compounds or with norstictic acid, connorstictic acid and several xanthones (UV+ orange).

Specimens examined — **SOUTH KOREA. Jeonnam:** Wando county, Cheongsan Island, 34°09.187′N 126°52.821′E, alt. 2 m, 23 Jun. 2011, Hur 110711 (KoLRI); Shinan county, Palgseun Island, 34°47.790′N 126°10.173′E, alt. 1 m, on rock, 2 Jun. 2011, Hur 110389 (KoLRI); Heuksan Island, 34°40.901′N 125°26.671′E, alt. 3 m, 21 Jun. 2011, Hur 110530 (KoLRI).

Comments — *Buellia prospersa* is easily separated from other Korean *Buellia* species by its yellowish surface (UV+ orange) and growth only on the coastal siliceous rocks.

Cosmopolitan but restricted to coastal areas (Nash et al. 2007), *B. prospersa* is new to South Korea.

Caloplaca yuchiorum Lendemer & C.A. Morse, J. Torrey Bot. Soc. 137: 328 (2010). Pl. 2d

Thallus gray-white, rimose-areolate, areoles plane, smooth, upper surface postulate, and pustules broken and forming soredia; prothallus black. Apothecia immersed to subimmersed, up to 0.7 mm, with only proper margin or with additional thalloid margin, proper margin black when prominent; disc dark brown to black, flat; exciple with or without algae; epihymenium light brown with blue-green, K+ light violet, N+ violet; hymenium 65–85 μm, with oil droplets; hypothecium hyaline, with oil droplets. Ascospores hyaline, 2 locules, ellipsoid, (9–)11–18 × (4–)4.5–7 μm, isthmus at least 1/3 of spore length. Pycnidia present, immersed, conidia bacilliform, 3.5–4.5 × 1–1.2 μm.

Spot tests — cortex: K+ yellow, C–, N–; medulla: K–, C–, N–.

Secondary metabolites — atranorin (thallus), anthraquinone pigment (epihymenium).

Specimens examined — **SOUTH KOREA. Gyeongnam:** Namhae county, Changseun Island, 34°51.891′N 127°57.705′E, alt. 2 m, on rock, 29 Apr. 2011, Hur 110280 (KoLRI); Tongyeong city, Salyang Island, 34°50.590′N 128°12.137′E, alt. 28 m, on rock, 20 Apr. 2011, Hur 110028 (KoLRI). **Jeonam:** Jindo county, seaside, 34°32.910′N 126°18.697′E, alt. 3 m, on rock, 3 Jun. 2011, Hur 110462 (KoLRI).

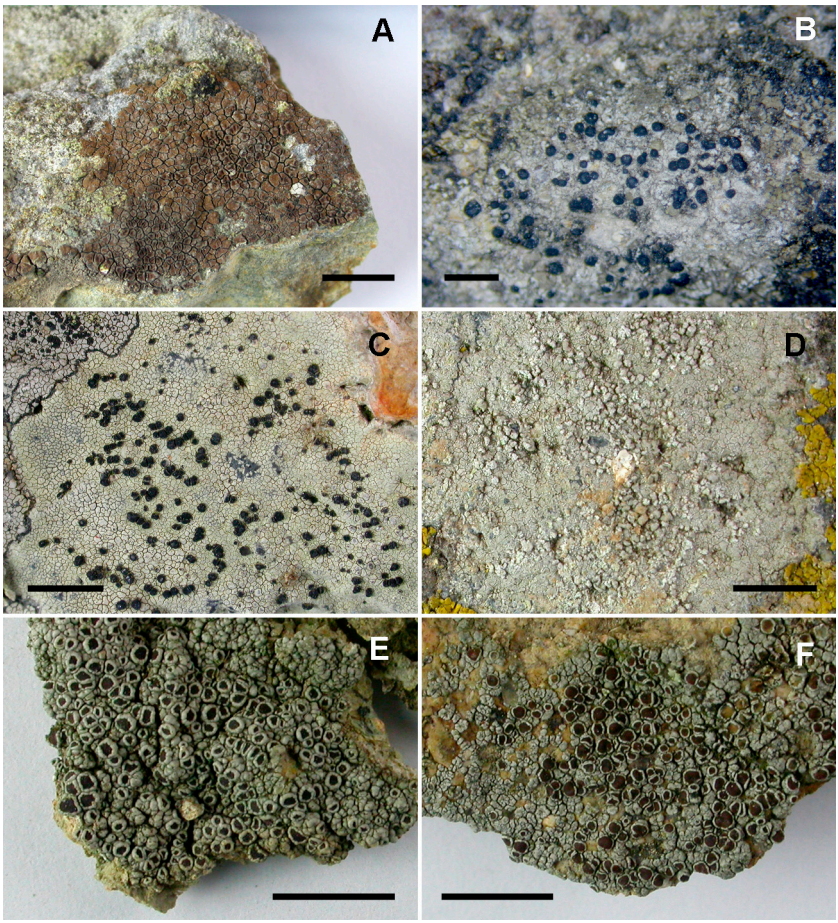

Plate 2. Habit of newly recorded lichens. A. *Acarospora veronensis*, Hur 110244; B. *Bacidia egenula*, Hur 110289; C. *Buellia prospersa*, Hur 110598; D. *Caloplaca yuchiorum*, Hur 110284; E. *Lecanora melacarpella*, Hur 110352; F. *Lecanora pseudistera*, Hur 110466. Scale bars: B = 1 mm; A, C–F = 5 mm.

Comments — *Caloplaca yuchiorum* is very similar to *C. diplacia*, which differs in having a sorediate thallus with a pale prothallus, smaller apothecia (0.3–1.0 mm wide), and an epihymenium with an anthraquinone pigment that reacts K + magenta.

Reported from North America (Lendemer & Morse 2010), *C. yuchiorum* is new to South Korea and Asia.

Lecanora melacarpella Müll. Arg., Bull. Herb. Boissier 3: 633 (1895) Pl. 2E

Thallus whitish to grayish white, crustose, uniform, continuous or dispersed verrucose to verruculose, epruinose; margins indefinite or definite, sometimes with a whitish prothallus. Apothecia sessile, constricted at base, 0.6–1.5 mm diam.; discs brown to dark brown, epruinose; margins smooth to verruculose or verrucose, prominent. Amphithecium with small K–soluble and large crystals; parathecium hyaline with small K–soluble crystals; epithecium without crystals, with a 2 μm high hyaline layer above; hymenium hyaline, 65–85 μm tall; hypothecium hyaline, inspersed with oil droplets. Ascospores ellipsoid, (9–)10.5–13.5 (–15.5) × (5.5–) 7.5–8.5 μm.

Spot tests — thallus: K+ yellow, C–, KC–, Pd+ light orange.

Secondary metabolites — atranorin, zeorin, unidentified triterpenoid (minor).

Specimens examined — **SOUTH KOREA**. **Gyeongnam:** Namhae county, Mt. Mangeun, 34°51.076′N 127°49.605′E, alt. 165 m, 29 Apr. 2011, Hur 110144 (KoLRI). **Jeonam**: Jindo county, Jeob-do Island, 34°23.091′N 126°18.250′E, alt. 2 m, 3 Jun. 2011, Hur 110516 (KoLRI); Shinan county, Palgeum Island, 35°47.734′N 126°10.219′E, alt. 2 m, 2 Jun. 2011, Hur 110352 (KoLRI).

Comments — *Lecanora melacarpella* is similar to *L. gangaleoides*, which is diagnosed by gangaleoidin and a thicker, verrucose thallus.

Reported from Australasia and India (Lumbsch & Elix 2004, Galloway 2007), *L. melacarpella* is new to South Korea.

Lecanora pseudistera Nyl., Flora 55: 354 (1872). Pl. 2F

Thallus yellowish gray or whitish gray, crustose to subsquamulose, surface smooth and epruinose, without soredia, verrucose-areolate or dispersed-areoles. Apothecia 0.4–1.5(–2.0) mm in diam., red-brown to brown, plane, epruinose, subimmersed to sessile; margins concolorous with thallus, thin or thick, persistent, entire or flexuose, even and entire; amphithecium with large crystals insoluble in K; epithecium without crystals, red-brown to orange-brown; hymenium hyaline, c. 60 μm high, paraphyses with a clear cap; subhymenium hyaline, c. 20 μm. Ascospores, hyaline, simple, ellipsoid, 9–15 × 5–7 μm. Pycnidia not seen.

Spot tests — thallus: K+ yellow, C–, KC–, P+ light orange.

Secondary metabolites — atranorin, 2'-O-methylperlatolic acid.

Specimen examined — **SOUTH KOREA**. **Jeonam:** Jindo county, seaside, 34°32.910′N 126°18.697′E, alt. 3 m, on rock, 2 Jun. 2011, Hur 110461, 110466 (KoLRI).

Comments — *Lecanora pseudistera* is very similar to *L. campestris*, which has small crystals in the amphithecium and lacks 2'-O-methylperlatolic acid.

Reported from Europe, the Americas, Asia, South Africa, and Australasia (Lumbsch & Elix 2004), *L. pseudistera* is new to South Korea.

Lecanora strobilina (Spreng.) Kieff., Bull. Soc. Hist. Nat. Metz 19: 72 (1895). Pl. 3A

Thallus greenish gray to yellowish gray, crustose, without soredia, poorly developed or granular-warted with areoles or rimose; areoles convex, 0.1 – 0.2 mm in diameter; Apothecia rounded or slightly irregular in outline, rarely single, mostly densely crowded, 0.30–0.40 mm in diam.; disc yellowish ochre to orange-brown, flat to moderately or rarely strongly convex, dull, finely white pruinose; margin white, pale gray or more rarely of same color as the thallus. Amphithecium present, with an algal layer filled with small granules; epihymenium orange-brown; hymenium hyaline, (35–)40–50 μm tall; subhymenium hyaline. Ascospores hyaline, simple, narrowly ellipsoid, (8.5–)10.6–12.4(–16.5) × (3–)3.3–3.8(–4.5) μm.

Spot tests — thallus: K–, C–, KC–, P–.

Secondary metabolites — usnic acid, decarboxysquamatic acid, ± zeorin.

Specimen examined — **SOUTH KOREA. Jeonam:** Jindo county, Jeob-do Island, 34°23.091′N 126°18.250′E, alt. 2 m, on the *Pinus* bark from the coastal region, 3 Jun. 2011, Hur 110513 (KoLRI); Hachodo Island, 34°16.592′N 126°04.215′E, alt. 22 m, on the *Pinus* bark from the coastal region, 23 Aug. 2011, Hur 110854 (KoLRI); Shinan county, Bogil Island, 34°09.275′N 126°34.740′E, alt. 3 m, on the *Pinus* bark from the coastal region, 23 Jun. 2011, Hur 110635 (KoLRI); Palgeum Island, 35°47.790′N 126°10.173′E, alt. 1 m, on the *Pinus* bark from the coastal region, 2 Jun. 2011, Hur 110392 (KoLRI).

Comments — *Lecanora strobilina* is very similar to *L. confusa* but distinguished by absence of xanthones and lower hymenium (not exceeding 70 μm).

Reported from Europe, Macaronesia, North America, Asia, and Africa (Smith et al. 2009), *L. strobilina* is new to South Korea.

Lecidea varians Ach., Syn. Meth. Lich.: 38 (1814). Pl. 3B

Thallus grayish green to yellowish green, thin, without soredia, mostly continuous, sometimes warted-aerolate, rimose or rarely endosubstratal thallus. Apothecia small and rounded, 0.15–0.4 mm in diam., often in groups of 3–5, sessile; disc brown to reddish brown, with or without white pruina, plane to weakly convex; margin weakly prominent and soon excluded or lacking from the beginning; exciple brown at the outer edge, hyaline interior; epihymenium brown; hymenium hyaline, 50–70 μm high, subhymenium and hypothecium hyaline. Asci *Lecanora*-type, ascospores hyaline, simple, ellipsoid to broadly ellipsoid, 8–13 × (4–)5–7 μm.

Spot tests — thallus: K+ yellow, C–, P–, UV+ orange.

Secondary metabolites — atranorin, xanthones.

Specimen examined — **SOUTH KOREA. Gyeongnam:** Tongyeong city, Salyang Island, 34°51.045′N 128°12.364′E, alt. 45 m, on the *Prunus* bark from the coastal region, 20 Apr. 2011, Hur 110035 (KoLRI).

Comments — Although *L. varians* does not belong to *Lecidea* s. str., we retain it here because its generic position is still unclear.

Reported from North America and Europe (Nash et al. 2004), *L. varians* is new to South Korea and Asia.

Ochrolechia tartarea (L.) A. Massal., Ric. auton. lich. crost.: 30 (1852). Pl. 3c

Thallus pale to dark gray, often very thick, to 3 mm or more, surface soft, powdery-tartareous, often with numerous irregular warts forming an uneven corrugate crust, sometimes with a paler zoned margin and a pale prothallus. Apothecia usually frequent, immersed and closed at first, becoming rounded or irregular, scattered or crowded, sessile; thalline exciple thick, wavy; disc to 5 mm diam., pale brown to dull orange-pink, concave to flat, the surface often scabrose-roughened; epihymenium granular, the granules dissolving in K; hymenium 200–300 µm; hypothecium light yellow. Ascospores (30–) 40–70 × 20–40 µm, broadly ellipsoid.

Spot tests — cortex and medulla: K–, C+ pink, KC+ red, Pd–; apothecial disc C+ red.

Secondary metabolites — gyrophoric acid, lecanoric acid.

Specimens examined — **SOUTH KOREA**. Gyeongnam: Namhae county, Mt. Daebang, 34°51.006′N 127°59.427′E, alt. 87 m, on rock, 20 Apr. 2011, Hur 110274 (KoLRI). **Jeonam**: Wando county, Cheongsan Island, 34°09.187′N 126°52.821′E, alt. 2 m, on rock, 23 Jun. 2011, Hur 110733 (KoLRI).

Comments — Its tartareous C+ pink thallus distinguishes *O. tartarea* from the morphologically similar *O. parella,* which produces a thallus that is fissured and C + yellow.

Reported from Europe, Macaronesia, North America, Asia, Africa, and subantarctic (Galloway 2007, Smith et al. 2009), *O. tartarea* is new to South Korea.

Pertusaria flavicans Lamy, Bull. Soc. bot. Fr. 25: 427 (1878). Pl. 3d

Thallus crustose, epilithic, rather thick, surface roughened, irregularly coarsely warted, usually continuous, slightly rimose to areolate, yellowish gray to light yellowish; areoles irregular in shape or rounded, flat or sometimes slightly convex, ≤1 mm in diameter, sometimes papillae present; prothallus absent; yellow soralia on the surface, abundant, 0.5–1 mm in diameter, often gathered in the central part of the thallus, color paler than the thallus, coarsely granular; isidia absent. Apothecia and pycnidia not seen.

Spot tests — thallus: K–, C+ orange, KC+ orange, P–.

Secondary metabolites — norstictic acid, salazinic and xanthones (UV+ orange).

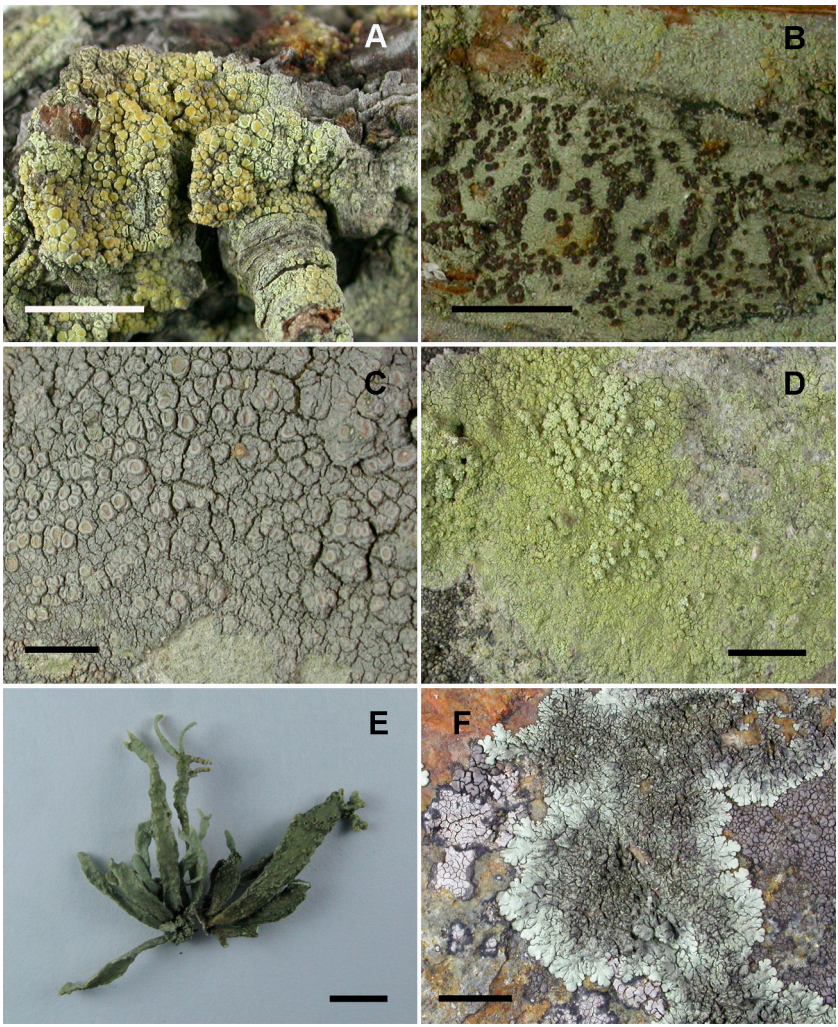

Plate 3. Habit of newly recorded lichens. A. *Lecanora strobilina*, Hur 110513; B. *Lecidea varians*, Hur 110035; C. *Ochrolechia tartarea*, Hur 110274; D. *Pertusaria flavicans*, Hur 110259; E. *Ramalina sekika*, Hur 110645; F. *Xanthoparmelia congensis*, Hur 110949. Scale bars = 5 mm.

Specimens examined — **SOUTH KOREA. Gyeongnam**: Tongyeong city, Salyang Island, 34°51.016′N 128°11.985′E, alt. 300 m, on rock, 20 Apr. 2011, Hur 110050 (KoLRI). **Jeonam**: Wando county, Cheongsan Island, 34°12.218′N 126°54.357′E, alt. 5 m, on rock, 23 Jun. 2011, Hur 110757 (KoLRI). **Jeonbuk**: Gunsam city, Shinsi Island, 35°49.091′N 126°28.159′E, alt. 141 m, on rock, 22 Aug. 2011, Hur 110780 (KoLRI).

Comments — *Pertusaria flavicans* is easily recognized by its yellowish (UV+ orange) thallus, yellow soralia, and growth only in the coastal rocks.

Reported from Europe, Macaronesia, and Asia (Smith et al. 2009), *Pertusaria flavicans* is new to South Korea.

Ramalina sekika Asahina, Journ. Jap. Bot. 17: 138 (1941). Pl. 3e

Thallus growing on the rock, fruticose, erect and forming tufts, attached by a basal holdfast, surface dull yellowish green or grayish green, turning brownish near the base, 1–3 cm long, with a few branches; branch 2–5 mm wide, flattened and solid, wider in the middle part, irregularly branched near the tips; surface rather scabrid, covered with numerous pseudocyphellae surrounded by granules, the other side of the surface often smooth and yellowish; cortex thin, composed of thick-walled hyphae, medulla white; Apothecia and pycnidia not found.

Spot tests — cortex: K–, C–, KC+ yellow; medulla: K–, C–, KC+ pale red.

Secondary metabolites — usnic, sekikaic, 4'-O-demethylsekikaic and ±salazinic acids.

Specimens examined — **SOUTH KOREA**. **Gyeongnam:** Namhae county, seaside, 34°48.853′N 127°49.698′E, alt. 2 m, on rock, 28 Apr. 2011, Hur 110219 (KoLRI). **Jeonam**: Yeonggwang county, West seaside, 35°19.635′N 126°22.695′E, alt. 2 m, on rock, 1 Jun. 2011, Hur 110299 (KoLRI); Wando county, Cheongsan Island, 34°09.187′N 126°52.821′E, alt. 2 m, on rock, 23 Jun. 2011, Hur 110707 (KoLRI).

Comments — *Ramalina sekika* usually grows together with *R. pollinaria*; both species have similar habitat and morphology, but *R. pollinaria* has fine soralia on the surface and marginal part, while *R. sekika* has rough surface covered with pseudocyphellae and usually contains salazinic acid.

Reported from China and Japan (Asahina 1941, Wei 1991), *Ramalina sekika* is new to South Korea.

Xanthoparmelia congensis (J. Steiner) Hale, Phytologia 28: 486 (1974). Pl. 3f

Thallus foliose, tightly adnate on the rock, 2–5 cm broad, dark yellowish green in the central part, turning light yellow-green near the tips; lobes rather narrow, sublinear, 0.2–0.6 mm wide, sometimes branched, tips subrounded to rounded; upper surface shiny, covered with dense globose isidia, ≤0.1 mm in diameter, paler than the thallus, mainly in the central part of the thallus, tip part sometimes bursting open but not becoming sorediate, without any branches; medulla white; lower surface black and shiny, plane and smooth, black rhizines sparse, simple, c. 0.3 mm long; Apothecia and pycnidia not seen.

Spot tests — cortex: K–, C–, KC–, P+ orange; medulla: K+ yellow to red, C–, KC–, P+ orange.

Secondary metabolites — stictic acid (major), constictic, cryptostictic, norstictic, menegazziaic and usnic acid.

Specimens examined — **SOUTH KOREA**. **Jeonam:** Gohong county, Wenaro Island, 34°27.236′N 127°31.153′E, alt. 8 m, on rock, 24 Aug. 2011, Hur 110219 (KoLRI). Shinan county, Heuksan Island, 34°39.882′N 125°26.189′E, alt. 5 m, on rock, 21 Jun. 2011, Hur 110557 (KoLRI).

Comments — Compared with other Korean *Xanthoparmelia* species, *X. congensis* is relatively small in size and found only in the seaside rocks. It might be confused with *X. orientalis,* which also has the black lower surface, which is distinguished by its larger lobes (1–2. 5 mm) and different chemical compounds (usnic acid, salazinic acid, consalazinic acid, and trace of norstictic acid).

Reported from Mexico, South Africa, Australia, India and China (Hale 1990), *Xanthoparmelia congensis* is new to South Korea.

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